Since 1964, the leader in effective, safe and reliable products for fisheries conservation.
Knowledgeable biologists depend upon Smith-Root equipment.

USER'S MANUAL
BP-1.5 POW PULSER

SMITH-ROOT, INC.
Products for Fisheries Conservation

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Items manufactured by companies other than Smith-Root carry the original manufacturer's warranty. Please contact product manufacturer for return instructions.

All Smith-Root, Inc. manufactured products are covered by a one year warranty.

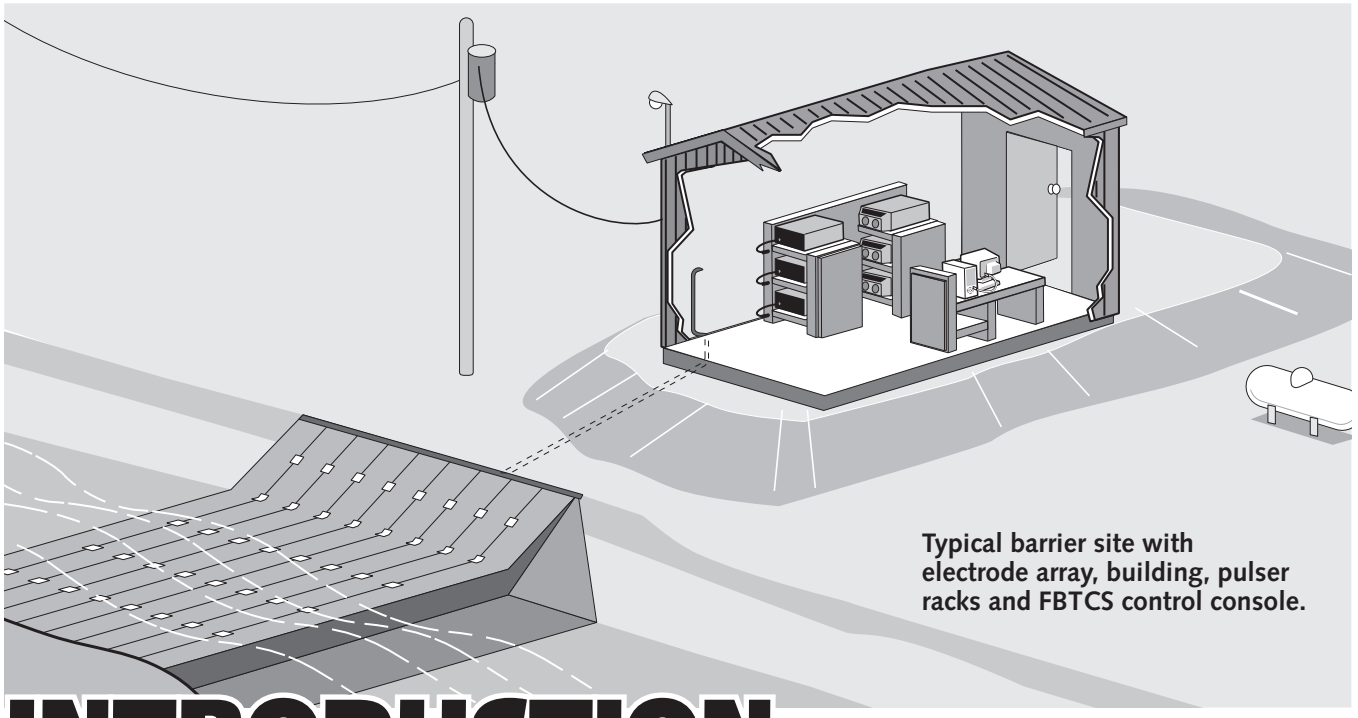
Credit & Refund Policy: Customers returning equipment, in new condition, will be given credit to the applicable VISA/Master Card account within five days from the date of the return. A return authorization must accompany returns. Valid equipment returns include, but are not limited to, ordering incorrect equipment, funding deficits, and defective equipment returned for reimbursement. All returns are subject to a restocking fee and applicable shipping charges. The restocking fee is figured at 10% of the purchase price but not less than $20.00. Customers receiving equipment in damaged condition will be referred to the shipping company for insurance reimbursement.

Rev. 042705-010

Control # _____

BP-1.5 POW

Programmable Output Waveform Pulser



Typical barrier site with electrode array, building, pulser racks and FBTCS control console.

INTRODUCTION

Electric fish barriers have been employed for many years to guide migrating fish away from protected waterways or water hazards. By charging the water with enough electricity to stun the fish, up stream migrations can be easily blocked since a stunned fish cannot swim and will be swept back down stream by the water flow. Down stream migrations are more difficult to block since the electric field must produce enough irritation to keep the fish out of the barrier area without actually stunning them. In both cases, the way the electric current is applied to the water must be tightly controlled so as to produce the desired response from the fish without injuring them.

Most early methods of charging the water used crude switching of AC line power. AC (alternating current) has been found to be much more damaging to fish than DC (direct current), so rectified AC (or pulsed DC) was tried. However, because of the rounded shape of this type of waveform, more power had to be applied to the water to produce the stunning effect, and little irritation could be felt by the fish before they were overcome by the charge, resulting in poor performance and damage to sensitive fish species. As concern grew over protecting endangered fish, it became obvious that better methods for applying the electric charge to the water were needed.

To date, the most effective waveforms seem to be narrow DC pulses with quick rising edges and duty cycles (the ratio of on to off times) much less than 50%. This kind of waveform produces the greatest irritation to the fish and causes the least amount of harm when used properly. However, the actual parameters of this kind of waveform still vary depending on the direction of fish migration, the average size of the fish, and other factors specific to the particular barrier implementation. For this reason, Smith-Root has created a line of pulse generators with very flexible and accurate control of the output pulse parameters.

THE BP-1.5-POW PULSERS

This line of barrier pulse generators (Pulsers) incorporates Smith-Root's patented Programmable Output Waveform (POW) technology. A built-in computer controls and monitors the output waveforms, and can send the operational status of the unit to remote monitoring equipment. The units can be connected in series to charge large, multiple electrode, barrier arrays, and their output waveforms can be synchronized for maximum effectiveness. They produce a wide range of DC pulse outputs to give more stopping power with less stress to fish.

The microprocessor in each POW pulser has direct control over all timing parameters of the output pulse waveforms, so a variety of waveforms can be generated without changes to the hardware. Highly reliable capacitive energy storage and solid-state power switching technology is employed in all POW Pulsers. This allows the units to maintain high available output power, reduce power line noise caused by intermittent loading and allows true square pulse waveforms to be generated.

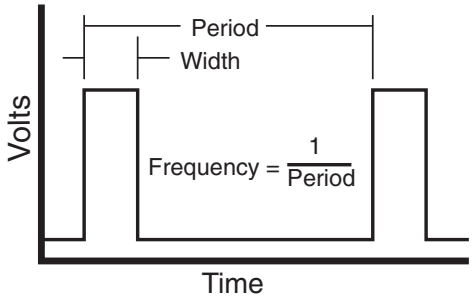
CONTROL NETWORK

Due to the complex nature of these units, most controls have been eliminated and replaced with a fiber-optic data communications network. Control and monitoring information is sent over this network to a central monitoring computer, such as the Fish Barrier Telemetry and Control System (FBTCS). Once configured, POW Pulsers can be operated without being connected to the data network, since all settings information is stored in nonvolatile memory inside each unit.

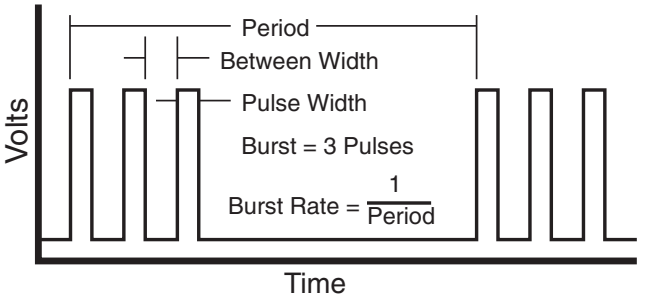
A separate fiber-optic network is provided to transmit triggering signals used in synchronizing the output waveforms of two or more POW Pulsers. When multiple POW Pulsers are connecated in this way, one becomes the master source of the synchronizing information and the others become slaves to that information. If the current master Pulser should fail, one of the other POW Pulsers in the system will become master. This provides redundancy and helps keep the barrier functional

SUPPORTED WAVEFORMS

Below are diagrams and descriptions of the types of output waveforms supported by the POW Pulsers. The first two are included as standard features.



Standard Pulse



Gated Burst of Pulses

Standard Pulse: A regular pattern of on/off times. The width and period of the pulses are selected to produce the desired response in the fish.

Gated Burst: A group of pulses followed by a longer off-time. This is often just as effective as standard pulses, but usually requires less power to achieve the same results. It may also be less stressful to the fish, particularly when trying to stun them.

Other Waveforms: Since the output is directly controlled by computer algorithms, almost any type of pulse waveform can be generated, limited only by the rate the output can be switched on and off. Sequences of pulses sweeping from wide-to-narrow width, or sequences sweeping from high-to-low frequency, can be implemented on special order.

FRONT PANEL

There are three indicator lights on the front panel of all POW Pulsers. The Green Power light indicates when the unit is powered up. The Red Trigger light flashes when an output pulse has been generated. The Red Fault light indicates that the output has been automatically turned off, even though the power to the unit is still on. There are four conditions that can cause the Fault light to come on:

Front Panel Indicator Lights

Programmed Shutdown: The FBTCS computer has instructed the POW Pulser to turn off it's output. This is provided so the FBTCS can temporarily shutdown the barrier if someone enters the area and is in danger of being shocked.

Average Power Overload: The power being used exceeds the safe operating limits of the unit. This can be corrected by using a waveform with a lower duty cycle (ratio of on to off times).

Peak Current Overload: The maximum electrical current produced by the unit exceeds safe operating limits. This is usually caused by a short circuit of the Pulser's output.

Over Temperature Fault: The temperature of the transformers in the unit is too high. If no other fault conditions are detected, this fault will clear itself when the temperature falls within the acceptable range.

The first three fault conditions will last until the Pulser has been reset, either by a command from the FBTCS or by turning the Pulser power off and then on again. Once reset, the Pulser will try generating output pulses again. If the fault was caused by an overload, a reset is not advised until the cause has been corrected, as this places undue stress on the output switching components of the Pulser.

REAR PANEL

The picture below shows the typical back panel of a POW barrier Pulser.

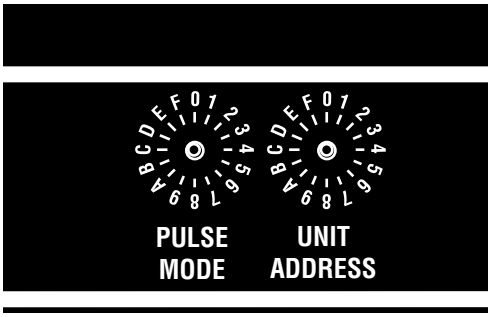
At the top center of this panel are 16 position rotary switches labeled "**Pulse Mode**" and "**Unit

ON
OFF
CIRCUIT BREAKERS
OUTPUT DC pulse 600A 350V 1.5kW
1+
2+
PULSED VOLTAGE MACHINE
1-
2-
PULSE MODE
UNIT ADDRESS
WARNING
RISK OF ELECTRICAL SHOCK.
READ INSTALLATION AND OPERATING INTRUCTIONS BEFORE USING.
FOR INDOOR USE ONLY - DO NOT EXPOSE TO RAIN OR MOISTURE.
AVERTISSEMENT
RISQUE DE CHOC ÉLECTRIQUE.
LISEZ L'INSTALLATION ET LES CONSIGNES D'UTILISATION AVANT UTILISATION.
POUR L'USAGE D'INTÉRIEUR SEULEMENT - N'EXPOSEZ PAS À LA PLUIE OU À L'HUMIDITÉ.
ATTENTION
TO REDUCE THE RISK OF ELECTRICAL SHOCK, DO NOT REMOVE COVER.
REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.
ATTENTION
POUR RÉDUIRE LE RISQUE DE CHOC ÉLECTRIQUE, N'ENLEVEZ PAS LA COUVERTURE.
RÉFÉREZ-VOUS L'ENTRETIEN AU PERSONNEL DE SERVICE QUALIFIÉ.
TRIGGER
DATA
SMITH-ROOT, INC.
BP-1.5 POW
FISH BARRIER PULSATOR
U.S. Patent Nos. 5,327,854 and 4,750,451.
Canada Patent No. 1,304,442.
INPUT: 230/240 Volts 10 Amp AC 50/60 Hz. 1 Φ.
IP31
www.smith-root.com
INPUT: 230/240 Volts 10 Amp AC 50/60 Hz. 1 Φ.
THIS PRODUCT IS PROVIDED WITH A MEANS FOR GROUNDING METAL PARTS THROUGH THE GROUNDING PIN OF THE POWER SUPPLY CORD. DO NOT REMOVE THE GROUNDING PIN.
CE PRODUIT EST ÉQUIPÉ D'DES MOYENS POUR FONDRE DES PIÈCES EN MÉTAL PAR LE PIQUET DE MISE À LA TERRE DE LA CORDE D'ALIMENTATION D'ÉNERGIE. N'ENLEVEZ PAS LE PIQUET DE MISE À LA TERRE.
AUX. ALARM
C NO NC
SERIAL NO.

Rear Panel layout

PANEL ITEMS Cont.

Address". The unit must be off before adjusting the position of these switches. They are inset and can only be adjusted by using a small, flat blade screw driver or other similar tool. The **Pulse Mode** switch of all pulsers must be set to the same value. The **Unit Address** must be set to unique values for each Pulser in a barrier system. If two Pulsers in a barrier system have the same **Unit Address**, the FBTCS could not talk to them over the data network and they may also cause other communication problems.



Pulse Mode and Unit Address Switches

The main power switch and circuit breakers are located in the top left corner of the back panel. There are two circuit breakers for normal 240 VAC operation, only one in a 120 VAC configuration, and three in a custom 3 phase connection (1.5KW model only).

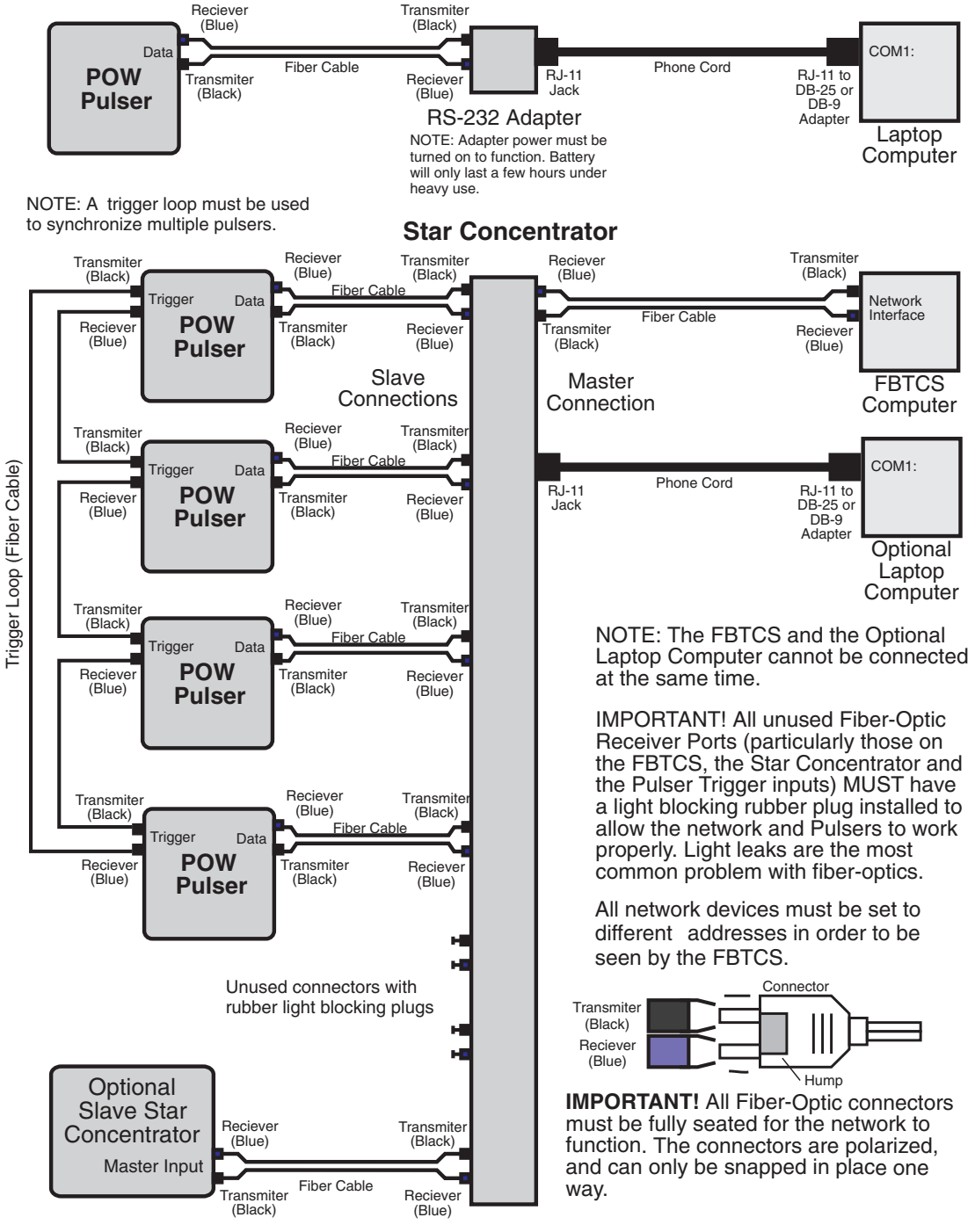
The high power output connectors are located just below the circuit breakers, with Red being the positive outputs and Black marking the negative outputs. The positive outputs are tied together internally, while the negative outputs come off independent solid-state switches. This allows the outputs to be tied together for greater combined power to one pair of electrodes, or used independently to charge three electrodes with the center electrode being the positive one. The output power from these Pulsers is isolated from chassis and earth ground, so several units can be connected together to charge larger electrode arrays. Output voltage is determined by wiring of the internal transformers and must be set at the factory or by qualified Smith-Root personnel.

The power input is just below the output connectors.

On the bottom center of the panel is a set of screw terminals marked "Aux. Alarm". These connections are for use with barrier systems that do not employ a central monitoring computer like the FBTCS, but which still need some way of signaling an alarm if there is a problem with the Pulsers. The Aux. Alarm terminals on the back of the unit provide access to a set relay contacts. Any circuit connected to these terminals must supply 24V or less at 1A or less AC or DC. NOTE: No power is supplied to these contacts from inside the pulser.

At the top left corner of the back panel are the fiber-optic Data and Trigger network connectors. Fiber-optic network cables were chosen over normal wire ones due to their immunity to electromagnetic noise and the isolation they give between the high power Pulsers and the more sensitive monitoring computer. Since light is used to transmit information over these cables, care must be taken to insure that no stray light can enter the network. These connectors require that a special rubber "plug" be placed in each hole, two per connector, if a trigger or data network connection is not used. Failure to fill these connector holes with either a valid fiber-optic network cable connector or these rubber plugs will result in poor or erratic behavior of the POW Pulser due to stray light entering the connector.

FIBER-OPTIC DATA NETWORK CONNECTIONS



NOTE: The FBTCS and the Optional Laptop Computer cannot be connected at the same time.

IMPORTANT! All unused Fiber-Optic Receiver Ports (particularly those on the FBTCS, the Star Concentrator and the Pulser Trigger inputs) MUST have a light blocking rubber plug installed to allow the network and Pulsers to work properly. Light leaks are the most common problem with fiber-optics.

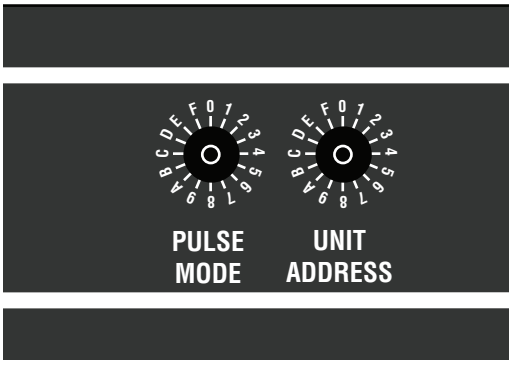
All network devices must be set to different addresses in order to be seen by the FBTCS.

IMPORTANT! All Fiber-Optic connectors must be fully seated for the network to function. The connectors are polarized, and can only be snapped in place one way.

WARNING: Do Not change data or trigger network connections while any POW Pulsers in the system are still running. Signals caused by stray light into a connector will be sent to all units on the network and can cause false triggers and other problems with the Pulsers.

VERSION 2.0 POW BARRIER PULSERS

With Version 2.0 firmware, our POW barrier pulsers have a manual method for setting the output waveform parameters. This is done with the Pulse Mode Switch. The Unit Address switch still selects the network address for the unit, which can now only range from 0 through 15 (0-F Hex). The Pulse Mode switch now selects from a table of 16 preset waveforms. All of these preset waveforms can be modified by network commands, and the changes will be retained through a power reset. A diagram of these switches and the factory default settings for these preset waveforms are shown below:



The Default Waveform Table				
Pulse Mode	**Pulse Type**	**Pulse Width**	**Pulse Frequency**	**Power-up State**
0	Standard	5ms	2Hz	OFF
1	Standard	5ms	2Hz	ON
2	Standard	7ms	2Hz	ON
3	Standard	10ms	2Hz	ON
4	Standard	5ms	2.5Hz	ON
5	Standard	7ms	2.5Hz	ON
6	Standard	10ms	2.5Hz	ON
7	Standard	5ms	3Hz	ON
8	Standard	7ms	3Hz	ON
9	Standard	10ms	3Hz	ON
A (10)	Standard	1ms	5Hz	ON
B (11)	Standard	3ms	5Hz	ON
C (12)	Standard	5ms	5Hz	ON
D (13)	Standard	1ms	10Hz	ON
E (14)	Standard	3ms	10Hz	ON
F (15)	Standard	5ms	10Hz	ON

Note that the first switch position (0) powers up in the “Output OFF” state where as all other positions power up in the “Output ON” state. In barriers that must be automatically turned off for safety reasons, this first switch position is the default so the barrier remains off until the controller determines that it is safe to turn it on.

RESTORING BARRIER OPERATION ON VERSION 2.0 PULSERS

In the event that the barrier controller fails while the pulsers are in the "Output OFF" state, just turn all the pulsers off and set the Pulse Mode Switch on each pulser to one of the positions other than zero. Then turn the power for each pulser back on, starting with the first one (the one with the lowest network address). All units should start pulsing after a short startup delay.
All pulsers should be set to the same Pulse Mode Switch position. You should start with low switch numbers and work your way up to higher numbers until the desired output power level is reached (the fish are repelled without being harmed).
Remember, all changes to these switch settings should be made with the pulsers OFF!

INSTALLATION

Please consult with Smith-Root personnel for information on proper installation and configuration of these POW pulsers. We will do our best to examine your situation and provide a solution that meets your needs.

MAINTENANCE

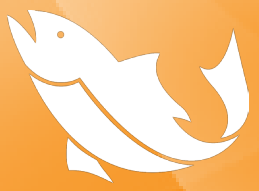
Should the power cord become damaged, it must be replaced by Smith-Root or our service agent with a special cord available from Smith-Root.

CLEANING

The BP-1.5 enclosure may be cleaned with warm water and a mild soap solution.
Spray the solution on the area to be cleaned and then wipe with a soft cloth.
CAUTION: Do not use solvents on the case of the BP-1.5 as they may cause permanent damage to the paint and decals.

SPECIFICATIONS

Input voltage	Standard 240 Volts, single phase, 50-60Hz AC
Input voltage, special order	120 Volts, single phase, 50-60Hz AC 240 Volts, three phase, 50-60Hz AC
Output voltage (Pulsed DC)	56, 112, 168, 224, 280, 336 V
Maximum input current	10 Amps
Maximum output energy	1860 Joules
Output insulation rating	5,000 Volts for 1 minute
Output current, maximum	1,200 Amps
Pulse width	0.15 to 10.0 Milliseconds
Pulse Frequency or Burst Rate	0.1 to 10.0 Hz
Dimensions	16.5”W x 10.5”H x 27”D
Weight	120 Pounds
Operating temperature	0–40°C (32–104°F) Relative humidity 5 to 95 percent, non-condensing.
Capacitor bank	33,000 µF
* Specifications subject to change without notice	



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